STRUCTURING EXPERT-leaded MEDICAL PROTOCOLS for TELE-MEDICINE SYSTEMS

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Abstract - **The structuring of standardized medical protocols that can be used in distributed tele-medicine systems (TS) is dealt. The protocols are needed to handle the medical data exchange between TS; TS can be considered as an aggregation of medical data sources and communication servers. The medical protocols have been integrated in an already presented TS tested on the field by means of a pilot project consisting of twenty-two (22) medical nodes.**

Keywords - **Tele-medicine, SOAP, Medical Protocols**

I. INTRODUCTION

Few domains of human activities have changed so radically in data structure, focus, and process as health care. Medical data processing over the years changed the quality of health care provided, the location in which it is received, the extent up to which patients actively participate in their treatment, and the way the sources of primary, secondary, and tertiary care and community services are integrated [1].

Hellenes and Northern Europeans, generally are not receivers of as good health care as they could, given the regional environmental factors, and the scientific knowledge they can have access to [2]. Among the factors that need to be re-examined, re-assessed, or reformed in order to improve this situation, are [RACE-TeleMed DG13/96]:

- Re-establishing medical practices by cross-relating vast amounts of medical cases and treatments.
- Effectively applying preventive medicine.
- Rationalizing usage of pharmaceutics.
- Employing uninformative waiting in all its forms.
- Consolidating high-technology services.
- Integrating institutions of health care delivery.
- Associating MD specialists and rural physicians.
- Extending quality medical services in remote areas.

The concept of structuring medical protocols as a means to provide a systematic and consistent method for administering appropriate health care, has progressed along an amazingly organized pathway for at least two decades. I.e. as far as it regards respiratory care practice, the growth of respiratory care protocols is dated since 1981 [3].

The present work aims to describe the structuring and application of Expertise-leaded Medical Protocols (ELMP) for Tele-medicine Systems (TS). An organized set of standing orders based on patient-specific conditions, and objective assessments, will allow health care staff to communicate, initiate, alter, and discontinue medical services and shall experimentally form an 'electronic workspace' in an already utilized TS [4], [5], [6], [7].

The new concept ELMP also provide medical staff using the new TS (referred to as OTE-TS) [3], with a standardized, efficient, complete, and accurate tool to approach the so-called clinical problem solving at distance [9]. It grants health care providers with a new tool imparting higher quality of service that forwards the understanding, cooperation and, interaction skills of all TS users.

II. EXPERTISE -LEADED MEDICAL PROTOCOLS FOR TS

A. ELMP for TS: Design Principles

The formulation of a set of principles based on high quality medical performance through the e-workspace of OTE-TS, at the same time based on modern legislation, was set first in order to care a medical incident at distance. The principles for establishing ELMP for TS are listed bellow:

- The design is based on the best evidence available from clinical research and practice [4].
- Each focus on defined tasks for care at distance [2].
- All contain all accessible medical knowledge as is necessary to achieve a specific goal [2].
- Each responds to the medical conditions listed below:
  - acute medical incident,
  - chronic medical incident,
  - emergency case,
  - medical education.
- ELMP for TS address the MDs who are qualified and licensed to perform their defined medical tasks.
- All should be constantly reviewed so as to respond to the demand for medical practice based on the best evidence available from clinical research and practice.

B. Categories of ELMP for TS

The diagnostic, therapeutic, monitoring, preventive, and nursing purposes of the ELMP for TS, were referenced to structure a wide spectrum of specific disease-, sign- and symptom-, treatment-, risk factor-, and public health-based medical protocols. The structure organization best suited to their purpose [6] is directly related to the specific abilities of the OTE-TS and the required medical services:

1. To comply with the diagnostic purpose, ELMP are being equipped with patients' medical history, physical examination, differential diagnosis, laboratory examination results, consultation, and procedures data. The key rule is that a user must repeatedly choose between asking questions

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Abstract

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and listening to the answers, directing, and following an organized set of standing medical orders.

Data are related to the nature of the diagnostic application, the circumstances under which a diagnosis is asked, and the uses to which the resultant data will be put. ELMP access the severity and the urgency of the case, define a disorder, exclude mimics, consider the causes that underlie the differential diagnosis, narrow the differential diagnosis to two (2) conditions [8], [10] perform sequential investigation to confirm, and exclude all but the correct diagnosis.

2. Management purposes are achieved with ELMP focusing on non-drug, drug, and interventional therapy. Each consists of indications for specific therapies, criteria for the method of delivery, frequency of therapy used.

3. The structuring of monitoring-oriented ELMP refers to data acquisition, retention and processing, as well as the triggering of alarms. Such a structure implies the use of devices that obtain values from the distant patient without transgressing skin or mucous membranes, or entering inner body cavities. General principles are stated concerning the clinical application of non-invasive monitoring. The variables and their parameters monitor 'objective changes' [8], [11] of the SOAP (Subjective/Objective changes Assessment Plans) format which is generally composed of:

- Subjective elements: symptoms.
- Objective ones: signs, laboratory results, radiography.
- Assessment: data evaluation.
- Plans: therapy.

Criteria being used for evaluation purposes are:

- Tasks for which ELMP are planed to be used.
- The level of information required.
- The manner of presentation acceptable to the user.
- The circumstances of measurement.
- The compatibility with already used TS.

4. Prevention-oriented ELMP are groups of information used as guidelines for the realization of preventive goals, i.e. disease prevention and health education efforts, and environmental modification, that are the subject of primary prevention. Yet, secondary prevention is applied by ELMP by directing remote physicians to participate in screening programs and apply high quality primary medical care. In the end, prevention-oriented ELMP are being targeted towards promoting tertiary prevention by providing remote medical personnel with disorder-oriented information so as to work on disability limitation and on rehabilitation from an existing illness.

5. Nursing ELMP are groups of diagnostic/therapeutic guidelines that allow central nursing offices to communicate with remote patients [9], [12] so as to evaluate the situation, deliver health education and health promotion, allow monitoring of daily food intake, and administer simple medical self treatment. Move in-depth nursing ELMP are oriented to vital signs measurement and delivery of specific A/V therapies for disabled and handicapped remote patients.

All types of ELMP or their combinations contain elements that are easily acquainted, applied, transmitted, and evaluated on the e-workspace and correspond to the specific criteria for high quality remote medical practice.

III Assessment Tools for ELMP for OTE-TS

In order to provide for tools that aid MD specialists in their evaluation of patients on the e-workspace of OTE-TS, ELMP were made to aid skilled personnel in the collection of essential data about patients' condition and necessities. Such an orderly approach to patient assessment enables specialists to gather specific information from which to draw conclusions about the patient current health state and then move to the preventive, diagnostic, therapeutic, monitoring, and nursing procedures.

Tools currently available for illnesses assessment, provide not only a consistent method for patient evaluation but also information that can be used to help specialists determine the level and type of health care required as well as the frequency of the therapy. Structuring of the diagnostic ELMP was based on the measurement abilities of [10]:

- Digital input devices, such as ECG, spirometer, holter, blood pressure meter, oximeter, scales, camera, etc.
- Testing strips, such as cholesterol testing strips, glucose testing strips, triglyceride testing strips, etc.

IV. Quality Control of ELMP for OTE-TS

ELMP for OTE-TS must be monitored and evaluated to ensure that diagnostic therapeutic, and monitoring purposes within the actual workspace of primary, secondary, and tertiary sources of health services are fulfilled. A variety of methods are being used for checking the quality of service. They include case study exercises and reporting systems [4].

Case study exercises for both training and monitoring practitioners, as well as algorithms for care plan formulation were utilized for the proposed ELMP. The exercises include real cases that provide all distant preventive, diagnostic, therapeutic, monitoring, and nursing necessities.

The generated results from these particular case studies returned to the coordinators, were compared to, and given scores according to their correctness as determined by a consensus of the medical director, manager supervisors, and education director of a medical department. By examining the combined scores of practitioners for a specific diagnostic therapeutic or monitoring modality, the protocols that might need to be clarified or refined were determined.

An important method of ensuring that ELMP for OTE-TS are definitive and conclusive, is the ability to validate that the protocol addresses both the clinical need of each patient and telecommunication requirements. The development of reporting systems that enable MD specialists and engineers to review, discuss and, adjust the patient care plans within the OTE-TS, is essential for ensuring a quality protocol program.

A. Implementation of ELMP for OTE-TS

Construction and application of ELMP for OTE-TS, extend well beyond drafting a set of protocols. It include

defining related steps, identifying who, when, where and why does what determining competencies, and require training on the part of all participants and users of OTE-TS.

Associations of health care both national and international [1], [2], [9], provide well-supported references for indicating, need assessing, contradictions, precautions, monitoring, and outcome assessment, in developing ELMP.

The developers' team accumulated experience in the field of designing and implementing communication, diagnosis supporting, or medical image processing applications [4], [6], was the basis that led to the structuring of OTE-TS. MDs seemed to prefer simple and friendly terminals (e.g. PCs vs. workstations), equipped with visual interfaces and facilities for the organization and the fast and secure file handling. OTE-TS is provided with an integrated working PC platform, including tools for the support of multiparty co-operation schemes. Its architecture consists of:

- One (1) router, that is connected to a PRI (30B Channels) and is used for the establishment of dial-up ISDN connections among users and central database, combinatorially accessing as much number of channels as the local network and the free server ports allow.
- Network Support/Surveillance are supplied by OTE.
- The Communication Entity satisfies standardized ITU protocols [13], [14], and [15].
- The Administration Entity bridges the inter-operability of the server, the calls, and the router connections as set by the number of free server ports.

MDs' interaction with the proposed platform is boosted by, the combination of multimedia information technology and visual programming. Also, software tools for data management and handling, exchange of multimedia data (audio/voice/data) support, database maintenance, etc. were also integrated in the OTE-TS.

As far as it concerns the OTE-TS network, the following arrangements were put to use:

- A standard Network Terminal device (as supplied by OTE) connects an MD PC to the ISDN offering a transfer rate ability of an (1) ISDN BRI (128 Kbps).
- Special communication software has been designed to deal with the administrational and the application needs of the Tele-Medicine platform, the interoperability between a PC and a network terminal.
- The user interface supports Tele-Medicine applications with special care given to the ones independent of the tele-communication infrastructure.
- A PC-ISDN router services the database server (the PC that hosts the central database); it can handle up to eight (8) ISDN BRIs (e.g. 8×128 Kbps)
- A (1) document camera (752(H)×494(V) effective pixels) was also supplied to each terminal.

The aforementioned entities are responsible for the on-line (real-time collaboration) and off-line (a patient's case transfer) use of OTE-TS. Their implementation follows the H.320 and T.120 ITU-T recommendations (on-line use), and the LDAP (X.500) - SMTP (X.400) protocols. TCP/IP handles off-line file transfer [13], [14], and [15].

B. Evaluation of ELMP for OTE-TS

The pilot project for OTE-TS was applied to twenty-two (22) medical nodes (16 Health Centers and 6 General Hospitals) of Epeirus and Thessaly (rural Hellenic counties). 266 test and real medical cases were serviced (75/190 ratio), they consisted of 213 laboratory examinations, 505 medical images, a total of 112'459'591MB were exchanged (to and from) between Health Centers and Hospitals.

Fig. 1 shows the percentage rate of assisted medical cases at distance for the whole network of nodes, during the pilot project duration. These cases concerns real patients as treated in rural Health Centers that asked for the distant help of General Peripheral Hospitals. It is to the advantage of the whole system that the treated patients were not recovered to the said General Hospitals. Table 1 and 2 show the collaboration and overall rates for OTE-TS.

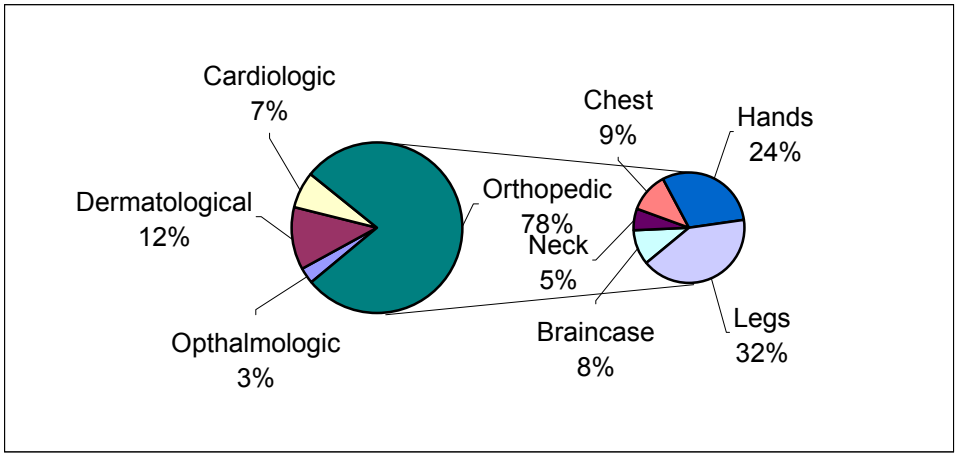

Fig. 1: Typical Utilization of OTE-TS spanning in Requested Medicine Fields

TABLE 1
Collaboration Ratings for OTE-TS

	Rates		
	(-2)+(-1)	0	(1)+(2)
Connection process	0	12	88
Connection time	0	8.3	91.7
Synchronous communication	0	0	100
File/message transfer	8	8	84
Sharing tasks	0	0	100

TABLE 2
Overall Ratings for OTE-TS

	Rates		
	(-2)+(-1)	0	(1)+(2)
Total Appreciation	0	0	100
Satisfaction using the system	0	0	100
motivate the users	0	0	100
The use of the tele-working system	0	0	100

V. DISCUSSION

Given the fact that ELMP for OTE-TS are designed to increase both the quality and efficiency of the health care services, especially in primary care settings, they also meet up the demand for patient-focused care, decentralization of hospital services and health care administering, integration of patient care processes, collaboration between in-hospital and out-hospital medical staff, and delivery of high quality medical services at a regional level (at distance).

MDs manning the pilot nodes embraced the new service with good results. Despite their unfamiliarity with computer systems in general, the networking equipment, and tele-conferencing services, they exhibited a genuine enthusiasm about the perspectives OTE-TS brings along. Moreover, the ELMP with the methodological approach to medical data that brings along, was accepted by MDs majority as a necessary platform to implement in their everyday routine.

The fact that they have to keep constantly informed and updated in medicine advances, they urge them to use tele-conference, virtually attend seminars, create, and learn from special set-up distance learning educational productions. On the other hand, the overall cost for installing, upgrading and maintaining such a service (and a Tele-Medicine Network), is much less than the cost of the ISDN calls transacted.

VI. CONCLUSION

ELMP for OTE-TS can play a substantial role in many newer models of patient care, especially in those addressed at rural and remote areas [12]. MDs in general are ready to embrace and utilize them, as the pilot project showed.

On the other hand, the new OTE-TS service is capable to convey unexploited human and material resources and to combine them with high-end technological solutions, in order to improve health care. OTE-TS can be used for its diagnostic prowess and also for other aspects of building services over tele-communication networks and systems: Tele-Education, Tele-Consultation, and Tele-Monitoring.

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